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# Annotated Bibliography of USAARL Technical and Letter Reports

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United States Army Aeromedical Research Laboratory  
Fort Rucker, Alabama 36362-5292

## Foreword

Technical reports and letter reports published by the United States Army Aeromedical Research Laboratory (USAARL) from October 1988 through April 1991 are included in this annotated bibliography, volume 2, dated May 1991. It does not include special reports, papers, articles published in professional or technical journals, proceedings, etc.

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For convenience and ease of use, the indexes of Volume 2 includes a running listing for both volumes. The **bold** numbers refer to reports in Volume 2.

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## **Section A.**

**Listing of technical reports  
by title and author with abstract.**

## **Fiscal Year 1988**

### **88- 1. Simulator sickness in the AH-64 Apache mission simulator. November 1987. (ADA193419)**

By Daniel W. Gower, Michael G. Lilienthal, Robert S. Kennedy, Jennifer E. Fowlkes, and Dennis R. Baltzley.

As technology has been developed to provide improved visual and motion systems in operational flight trainers and weapons tactics trainers, there have been increasing reports of the occurrence of simulator sickness. Simulator sickness here refers to one or more symptoms which can occur while in a simulator, immediately postexposure, or at some later time following exposure. Some pilots have reported while driving following postexposure, they have had to pull off the road and wait for symptoms to subside. Instructor-operators have reported experiencing "the room spinning" when they went to bed. More critical is the potential for in-flight problems due to prolonged physiological effects. The U.S. Army Aeromedical Research Laboratory at Fort Rucker, Alabama, conducted a field survey to document the extent of the simulator sickness problems at operational AH-64 simulator sites. The simulator sickness incidence rates and the relative frequency of specific symptoms are presented and correlational factors such as flight experience, simulator experience, and flight mode also are presented. The study reinforces the need for continued research related to system design, training methods, and crew rest guidelines between simulator and actual flight.

### **88- 2. Recovery of the visual evoked response in the cat following administration of diisopropylfluorophosphate, an irreversible cholinesterase inhibitor. (Reprint), December 1987. (ADA221118)**

By Albert W. Kirby, Thomas H. Harding, and Roger W. Wiley.

Visual evoked responses (VER) to counterphased gratings were recorded from area 17 of cat visual cortex prior to and following administration of diisopropylfluorophosphate (DFP). The VER and acetylcholinesterase (AChE) activity of blood, retina, and visual cortex were reduced significantly following DFP administration. Approximately 2 hours after exposure to 4 mg/kg DFP, the VER began to recover and in some cats returned to base line levels. In contrast, blood, retina, and cortex AChE activity showed little, if any, tendency for recovery throughout the experiment. Since atropine sulfate provided at least partial recovery of the VER following DFP without affecting AChE inhibition, an accumulation of acetylcholine (ACh) probably is involved in the initial visual loss. However, recovery of the VER over time while AChE remained severely inhibited implicates mechanisms other than, or in addition to, accumulation of ACh at receptor sites.

**88- 3. Disorientation accidents and incidents in U.S. Army helicopters 1 January 1980 to 30 April 1987. March 1988. (ADA198720)**

By Peter Vyrnwy-Jones.

Accident data was obtained from the U.S. Army Safety Center for all U.S. Army helicopter spatial disorientation accidents which occurred during the period beginning on 1 January 1980 and ending on 30 April 1987. During this time, there were 129 accidents caused by spatial disorientation which were responsible for 37 fatalities and 56 disabling injuries. Major causal factors are analyzed and recommendations made for changes in aircrew training, education, and aircraft instrumentation. Also discussed are the effects of operations undertaken in hostile environments.

**88- 4. Comparison of three anesthetics for chinchilla. April 1988. (ADA198719)**

By Clarence E. Hargett, Jr., Ilia M. Lomba Gautier, Melvin Carrier, Jr., Carol S. Landon, Irvin W. McConnell, and James H. Patterson, Jr.

Anesthesia techniques which successfully induce surgical anesthesia in Chinchilla villedera are described and compared. Two injectables, ketamine-acepromazine and ketamine-xylazine, are compared to halothane-nitrous oxide administered by mask only and the same mixture administered by induction chamber until loss of righting reflex and then mask. Forty laboratory-raised adult chinchillas in four groups were used in this study. Subjects were weighted and dosages calculated and administered. All achieved surgical anesthesia with no deaths. Time to loss of righting reflex, time to surgical anesthesia, duration of surgical anesthesia, time from end of surgical anesthesia to standing unaided, and total time from administration of anesthesia to standing unaided are detailed. Findings indicate that the doses evaluated of ketamine-acepromazine, ketamine-xylazine, and halothane-nitrous oxide all provide safe, dependable surgical anesthesia.

**88- 5. Anthropometry and mass distribution for human analogues, volume I: Military male aviators. March 1988. (ADA197650)**

By Harry G. Armstrong Aerospace Medical Research Laboratory, Naval Aerospace Medical Research Laboratory, Naval Air Development Center, Naval Biodynamics Laboratory, U.S. Air Force School of Aerospace Medicine, and U.S. Army Aeromedical Research Laboratory.

Anthropometric and mass distribution data for use in constructing three-dimensional human analogues---mathematical models or test dummies --are presented in this report. Included here are body dimensions, joint locations, and mass distribution properties appropriate for modeling the small, midsize, and large

male aviator of the 1980s. The data were derived from: (1) 139 body dimensions of standing and seated males obtained by traditional anthropometric methods; (2) mass distribution data for body segments obtained by stereophotographic techniques; and (3) skeletal joint centers obtained by estimation. The anthropometric data, generated from multiple regressions on stature and weight, are suitable as the basis for models to be used in testing responses to impact and other mechanical forces; they are not recommended for other purposes such as the sizing of clothing and personal protective equipment, or workspace design.

**88- 6. Comparison of Army flight school performance in smokers and nonsmokers.**  
May 1988. (ADA200429)

By Ronald J. Edwards, Michael G. Sanders, and Dudley R. Price.

The effects of smoking on performance were examined in this study by comparing flight school performance in groups of nonsmoking and smoking Army aviation students. Academic and in-flight grades for five phases of Initial Entry Rotary-Wing (IERW) classes between January 1984 and November 1986 were extracted from Aviation Center records and compared to the student's responses on the auxiliary questionnaire portion of the Aviator Epidemiology Data Register, a comprehensive database collected yearly from every Army aviator by the joint effort of the U.S. Army Aeromedical Research Laboratory and the Aeromedical Activity. There were 2,025 students with data sufficiently complete and analysis, with the average age of 24.5 years, and with a rank and sex distribution as follows: 96.3 percent males, 3.7 percent females; 53.2 percent commissioned officers, 46.7 percent warrant officers. Through past studies (1982) have shown 56 percent of all Army personnel were smokers, strict criteria defining smokers and nonsmokers in this study, plus recent decreases in smoking rates, produced a 15:85 ration of smokers to nonsmokers (recent quitters and those who smoke less than one pack/day were not included in the analysis).

That smoking is detrimental to overall health is clear from many controlled studies, however, using a very adequate number of aviators, no evidence of a statistically significant relationship was found between smoking behavior and flight school performance.

**88- 7. Effects of low and high oxygen tensions and related respiratory conditions in visual performance: A literature review.** June 1988. (ADA198688)

By Frederick N. Dyer.

Research was reviewed on the effects of hypoxia, hyperoxia, hypocapnia, and hypercapnia on a large number of visual and ocular processes. These included absolute visual sensitivity, dark adaption, visual acuity, contrast sensitivity, depth

perception, stereopsis, fields of peripheral and central vision, critical flicker/fusion frequency, color vision, afterimages, other entopic phenomena, persistence of vision following ischemia, the standing potential, the electroretinogram, ganglion cell and optic-trait responses, visual evoked responses, ocular vessels, blood flow, intraocular pressure, intraocular oxygen, the pupil, accommodation, myopia, the crystalline lens, convergence, heterophoria, reading, other eye movements, and the cornea. Research was also reviewed on the potential toxic effects of hyperbaric oxygenation on vision. Integration of this large body of research indicated probable dioptric changes in the eye during hypoxia that resulted from changes in blood volume associated with retinal vasodilation. One possibility is that anterior chamber "shallowing" occurs during hypoxia because of increased pressure behind the lens and/or reduced anterior chamber pressure. This may cause increases of myopia in some conditions. Since retinal oxygen requirements increase in darkness, a "night hypoxia" probably exists that may lead to "night myopia" as a result of this vascular oxygen regulation which leads to dioptric "deregulation." Research needs related to these and other hypotheses were identified along with gaps in research on the effects of hypoxia and hyperoxia on vision.

**88- 8. A comparison of two computer implemented psychophysical procedures applied to real-ear attenuation testing (ANSI S12.6-1984). June 1988. (ADA200431)**

By William R. Nelson and Ben T. Mozo.

The application of computer technology to acoustical instrumentation has significantly increased the capability and flexibility of modern acoustical laboratories. The need to replace old recording attenuators used in real-ear sound attenuation testing with state-of-the-art instrumentation prompted the combination of a CMOS multiplying D/A converter chip (which can accurately and reliably attenuate an analog signal) and a table-top computer to control the D/A chip. The computer also was used to record the measurement of auditory threshold, perform statistical analysis, and permanently store data. The flexibility of computer technology allowed the choice of psychophysical procedure. Consideration was given to two such procedures, tracking and method of adjustment. This study was undertaken to determine if one of these procedures would produce faster, more accurate results.

**88- 9. The triage process. (Reprint), July 1988. (ADA200628)**

By Glenn W. Mitchell.

Triage is a basic medical skill which is most commonly applied in mass disaster or combat situations to sort casualties. The number of patients and the care required exceeds the medical resources available, and the care rendered must be given on a rational and prioritized basis. Most previous published systems for dealing with

large numbers of patients have classification schemes based on medical diagnosis. This approach is difficult for paramedical providers (such as paramedics, emergency medical technicians, or combat medics) to implement without additional medical training and experience. This paper presents a simple initial patient classification scheme based only on recognition of shock symptoms. The BASIC mnemonic is described for delivery of initial care at a disaster field site. The scheme is suitable for implementation without physicians present until a hospital facility is reached. The differences between triage classification schemes required at various points in the rescue process also are discussed. The paper is one of a series of articles on disaster medical management originally published in the January 1986 edition of Topics in Emergency Medicine by Aspen Systems Corporation.

**88-10. SPH-4 helmet retention assembly reinforcement. July 1988. (ADA200432)**

By Ronald W. Palmer and Joseph L. Haley, Jr.

The purpose of a helmet's retention assembly is to keep the helmet firmly and securely in place on the wearer's head, thus preventing the exposure of the cranium to direct impact. The standard SPH-4 retention assembly is prone to excessive elongation under stress, and allows excessive helmet displacement and cranium exposure. A modified SPH-4 retention assembly, reinforced with 0.75-in. tubular nylon webbing, was manufactured in this laboratory and tested quasistatically on a testing machine which exerted a force at a constant speed. A standard SPH-4 retention assembly also was tested as a control. The reinforced retention assembly withstood a 450-lb load without failure. Elongation of the reinforced retention assembly, measured at 300-lb load, was almost 50 percent less than that of the standard retention assembly measured at the same load.

**88-11. A comparison of two whole-body vibration standards as applied to rotary-wing aircraft: ISO 2631 vs. ADS 27. July 1988. (ADA200430)**

By Dennis L. Breen and Barclay P. Butler.

Two whole-body vibration (WBV) standards, International Standards Organization (ISO) 2631 and Aeronautical Design Standard 27 (ADS-27), were compared using vibration signatures from the UH-1 and UH-60 helicopters. ISO 2631 is a widely used WBV standard which accounts for variables such as intensity, duration of exposure, frequency range, and vibration in all three orthogonal directions. ADS-27 is a newer standard developed at the U.S. Army Aviation Systems Command (AVSCOM) for measuring WBV produced by rotary-winged aircraft. An analysis of the two vibration signature types shows when vibration levels are measured on a pass/fail performance criteria, the ADS-27 becomes the more stringent standard; however, ADS-27 fails to answer the important health hazard questions that ISO 2631 attempts. ISO 2631 vibration acquisition techniques were found to be

more scientifically sound than those proposed by the ADS-27. The use of both standards may prove to be a more complete method of helicopter WBV assessment.

**88-12. Polycarbonate ophthalmic lenses for ametropic Army aviators using night vision goggles. August 1988. (ADA203100)**

By John K. Crosley.

U.S. Army aviators use the AN/PVS-5 night vision goggles (NVG) with a modified faceplate which enables wearing of corrective spectacles, when required. The next generation NVGs, the Aviator Night Vision Imaging System (ANVIS), permit spectacle wear by design. With only glass lenses available to the aviator requiring optical correction, there is a potential for eye injury from broken glass should the goggles accidentally be displaced. This report documents studies to (1) compare the impact resistance of glass, CR-39 (plastic), and polycarbonate lenses to simulated NVG tubes, (2) establish the approximate forces necessary to cause glass lens breakage by displaced NVG tubes, and (3) determine the performance of polycarbonate lenses in the aviation environment. Results demonstrate the significant improvement in impact-resistance afforded by polycarbonate ophthalmic lenses, verify the relatively low forces necessary to cause NVG displacement and subsequent glass lens breakage, and establish the feasibility of prescribing polycarbonate lenses for use by aviation personnel.

**88-13. The impact of the U.S. Army's AH-64 helmet mounted display on future aviation helmet design. (Reprint), August 1988. (ADA202984)**

By Clarence E. Rash and John S. Martin.

Historically, the goal of aviation helmet design has been to primarily provide impact and noise protection to the wearer. In 1984, the U.S. Army fielded an advanced attack helicopter which required a new helmet concept in which the role of the helmet was expanded to provide a visually coupled interface between the aviator and the aircraft. This new helmet system, the Integrated Helmet and Display Sighting System (IHADSS), uses a helmet fitted with infrared (IR) emitters and a monocular display. The IR emitters allow a slewable IR imaging sensor, mounted on the nose of the aircraft, to be slaved to the aviator's head movements. Imagery from this sensor is presented to the aviator through the helmet mounted display. This type system generates several concerns, recognized early on, but still unresolved. These areas include questions of monocular vs. binocular imagery, eye dominance, and binocular rivalry. Additionally, the task of interfacing the aviator's head to the aircraft has introduced previously unrecognized problems relating to head anthropometry and facial anatomy. The fitting process has become a crucial factor in the aviator's ability to interface with the aircraft systems. The development and fielding of the IHADSS helmet mounted display have expanded the role and importance of

the helmet. If helmet mounted displays are the design choice of future aircraft, it will be imperative to place increased emphasis on the human factors aspects of the helmet.

**88-14. The combat emergency medicine expert system (CEMES) project: Phase II report. August 1988. (ADA202590)**

By Douglas E. Landon and Glenn W. Mitchell.

The exploratory development of a Combat Emergency Medicine Expert System (designated CEMES) has been conducted. This report outlines the project's rationale and documents the major design concepts underlying the exploratory development of CEMES. CEMES is an expert system designed to perform automatic diagnosis and treatment of hemorrhagic shock with or without concurrent chemical agent contamination. Its anticipated use is as a forward-area medical aid, operating automatically following initial hands-on first-aid and system attachment by a medic, medic extender, or physician. A laboratory prototype CEMES has been designed and developed as a totally self-contained, closed-loop system. It monitors vital signs through noninvasive sensors and determines a diagnosis through vital sign analysis. It analyzes medical trends based on diagnostic and vital sign changes, and both warns for and guards against catastrophic or gradual deterioration in casualty condition. CEMES advises personnel as to when to initiate an IV or drug delivery line, and then automatically manages IV fluid infusion and periodic or continuous drug treatments based on current diagnosis and trends. CEMES monitor its own logistical status, advising as to when IV fluid is getting low and bag replacement is necessary. In addition, the logistical analysis watches for inoperative or malfunctioning sensors to facilitate degraded mode operation. CEMES also maintains a diagnostic and treatment history for examination by a physician at a definitive care facility. A color graphics display is used to present system information. Sensor data is simulated through off-the-shelf patient simulators and custom-designed simulation equipment. IV fluid infusion treatment is simulated using small pumps, colored water, and actual IV line tubing that delivers fluid at the rates prescribed by CEMES.

**88-15. SPH-4 U.S. Army flight helmet performance 1983-1987. August 1988. (ADA202589)**

By Peter Vwynry-Jones, Bernard Lanoue, and Douglas Pritts.

Injury data was obtained from the U.S. Army Safety Center for the occupants of U.S. Army aircraft who were wearing aviator helmets when involved in duty-related aircraft accidents from the period beginning in June 1982 and ending in October 1987. The injury data was correlated with the physical condition of the helmets involved which has been obtained by the U.S. Army Aeromedical Research

Laboratory under the Aviation Life Support Equipment Retrieval Program. The helmet performance was evaluated with regard to current injury prevention capabilities and potential improvements for future helmet designs. All helmets involved were involved in aircraft accidents except one SPH-4 which had been damaged by small arms fire.

**88-16. Contrast sensitivity in Army aviator candidates: Cycloplegia effects and population norms. September 1988. (ADA200433)**

By Isaac Behar, William G. Bachman, and Walter Egenmaier.

This study was designed to provide information regarding three aspects of sensitivity testing of aviator candidates: 1) To determine whether contrast sensitivity functions (CSFs) obtained with the VISTECH Visual Contrast Test System (VCTS) are affected by ocular cycloplegia; 2) since Army aviator candidates differ from the general population by being more highly selected with respect to visual and refractive status, and more homogenous in age and in an age bracket when vision is optimal, a second purpose was to obtain a large normative sample of CSFs for establishing future contrast sensitivity standards for this population; and 3) to determine whether the VCTS provides useful CSFs under clinical screening conditions in a timely and simple manner. Contrast sensitivity thresholds were obtained at 5 spatial frequencies from 106 aviator candidates, prior to and following the administration of a cycloplegic. Contrast sensitivity functions obtained under cycloplegia reduced about 20 percent. The CSFs of the aviator candidates are much superior than the general population norms. The VCTS provides useful CSFs under military screening conditions.

**88-17. Extended-wear soft and rigid contact lenses: Operational evaluation among Army aviators. September 1988. (ADA212554)**

By William G. Bachman.

With increasing technological complexity in Army aviation, the role of vision becomes more important. Aviation systems incorporating sophisticated electro-optical displays frequently are designed without provision for use by spectacle wearing pilots. Contact lenses offer a solution to the compatibility problems experienced by Army aviators, approximately 18 percent of whom wear corrective lenses. Under a waiver from The Surgeon General, 44 helicopter pilots performed flying duties while wearing extended wear soft and rigid lenses. Six experienced temporary discontinuance of wear (4-19 days); six withdrew from the study. No pilot was grounded due to contact lens related problems. Subjectively, extended wear contact lenses favorably affected job performance. This was the first major field evaluation of contact lenses in U.S. Army aviation, and eventually will represent part of a large database in this unique environment.

**88-18. TPL...installation, fitting, and maintenance for the SPH-4 helmet (Script for training video). September 1988. (ADA221534)**

By John V. Barson, Douglas P. Pritts, and Bernard A. Lanoue.

The thermoplastic line (TPL™) was accepted by the U.S. Army for use in the SPH-4 flyer's helmet in August 1988. This videotape demonstrates the U.S. Army Aeromedical Research Laboratory's techniques and procedures for installing, fitting, and maintaining the TPL™ in the SPH-4. Areas covered include TPL™ size selection, installation, fitting of the performed TPL™, care and maintenance of the TPL™.

### **Fiscal Year 1989**

**89- 1. Anomalous retinal correspondence. (Reprint), October 1988. (ADA203931)**

By Morris R. Lattimore, Jr.

This paper presents an overview of anomalous retinal correspondence in strabismus. Definitions, certain testing techniques, and a review of underlying theory are outlined. It is concluded at ARC is not well understood and represents an area still open for investigation.

**89- 2. The eyes have it: Contact lens impact on performance of armor troops. (Reprint), January 1989. (ADA205383)**

By Bruce C. Leibrecht and William G. Bachman.

Contact lenses, particularly the extended wear varieties, offer an appealing alternative for solving equipment compatibility and environmental problems faced by spectacle-wearing soldiers. This paper presents performance results from the Army's first major field investigation of contact lenses. The study evaluated extended-wear contact lenses in an operational armor environment. Male volunteers (N=311) from eight battalions of the 2d Armored Division at Fort Hood, Texas, wore contact lenses or spectacles for up to 6 months. They participated fully in their units' normal activities, including training in garrison and in the field. In response to questionnaires at the end of the study, nearly all of the contact lenses wearers were highly or moderately confident in their ability to see adequately. Most felt they could see better with their contact lenses than with spectacles. The greater majority indicated that contact lenses had improved their overall job performance, preferring contact lenses for a variety of military activities, operational settings, and environmental conditions.

Environmentally induced difficulties related to wearing contact lenses were infrequent except for conditions involving dust, wind, and smoke. Contact lens wearers and spectacle wearers alike frequently reported lens-related difficulties in the field environment.

Together with the study's data on ocular physiology and wear and care problems, these results form the cornerstone of the database needed to support establishment of comprehensive Army policy for contact lens use.

**89- 3. Inhalation anesthesia in the chinchilla. January 1989. (ADA205412)**

By Clarence E. Hargett and Jeffrey W. Record.

Inhalation anesthesia techniques which successfully induce surgical anesthesia in Chinchilla villidera are described and compared. Isoflurane-nitrous oxide and halothane-nitrous oxide delivered by a nonrebreathing system are compared to halothane-nitrous oxide delivered by a semiclosed system. Thirty-six laboratory raised adult chinchillas in three groups were used in this study. All achieved surgical anesthesia with no deaths. Time to loss of righting reflex, time to surgical anesthesia, duration of surgical anesthesia, and time from end of surgical anesthesia until standing unaided were recorded. Findings indicate that isoflurane-nitrous oxide delivered by a nonrebreathing system provides superior results.

**89- 4. The relationship between cognitive ability and the iconic processing of spatial and identity information. February 1989. (ADA208586)**

By Robert L. Stephens.

The present investigation established the reliability of a classification technique which separates subjects into groups based on individual differences in the ability to process spatial location and identity information tachistoscopically presented displays. Performance of the two groups then was compared on an iconic processing task which required the simultaneous processing of both location and identity information. Results indicated those subjects who process location information well performed significantly better on the Averbach-Coriell bar probe task than subjects who process identity information well. Subjects also were administered a battery of cognitive tests to determine whether differences at the iconic level are related to performance at more molar levels of recognition. Results of a series of correlational analyses indicated that a relationship does not exist between iconic ability and more molar cognitive abilities.

**89- 5. Anthropometric measurements of aviators within the aviation epidemiology data register. March 1989. (ADA208609)**

By Robert H. Schrimsher and Thomas J. Burke.

Twenty anthropometric measurements on 22,000 male flight school applicants, 29,000 male aviators, 800 female flight school applicants, and 600 female aviators are recorded in the Aviation Epidemiology Register (AEDR). Summary statistics for the anthropometric measurements of these four populations, including mean, standard deviation, and the 1, 5, 50, 95, and 99 percentile value, are reported. These values are reported in a tabular format with the corresponding values from five other Department of Defense anthropometric studies.

**89- 6. Cockpit lighting compatibility with image intensification night imaging systems: Issues and answers. (Reprint), May 1989. (ADA210503)**

By Clarence E. Rash and Robert W. Verona.

Night imaging systems based on image intensification ( $I^2$ ) tubes are a major factor in the night operation capability of U.S. Army rotary-wing aircraft. A major problem associated with the use of these systems is the detrimental effect caused by internal cockpit lighting. Instrument lamps, caution lamps, utility lights, and other light sources inside the cockpit activate the bright source protection control circuits of the intensification tubes, thereby reducing their sensitivity to external natural and artificial illumination. In 1986, a Tri-Service specification, MIL-L-85762, "Lighting, aircraft, interior, night vision imaging system compatible," was adopted to resolve the cockpit lighting problems. MIL-L-85762 defines the measurement instrumentation and techniques required to certify lighting components as "ANVIS compatible." The specification does not address compatibility problems associated with AN/PVS-5 usage. Ongoing efforts related to MIL-L-85762 include characterization of lighting incompatibilities in current U.S. Army aircraft, implementation of programs to modify the lighting in incompatible cockpits, and certification of proposed lighting components for future aircraft systems. Additional work has been done to provide "near compatible" solutions to lighting problems associated with the use of AN/PVS-5 systems.

**89- 7. Glucose concentration profiles of normal and radiation-exposed rabbit corneas. (Reprint), May 1989. (ADA221152)**

By Morris R. Lattimore, Jr.

The passage of glucose within the cornea has been thought to occur by passive diffusion processes. However, corneal glucose concentration profiles have not been established to support this notion. While microfluorometric methods of metabolite

assay typically have been used as a means of assessing regional brain metabolism, this unique methodology of tissue isolation and metabolite determination has not previously been applied to the cornea. Since this technique permits metabolite quantification on microgram-sized tissue samples, a coordinated corneal glucose concentration profile can be obtained. Tissue preparation consisted of liquid nitrogen freezing, cryo-sectioning, and freeze-drying, with storage at -20 degrees C. The sections were thawed under vacuum pump, subsectioned, weighed, and assayed for glucose concentration (by dry weight). This study established a glucose concentration profile of the epithelium, anterior stroma, midstroma, posterior stroma, and endothelium for the normal pigmented rabbit cornea. A glucose concentration profile for UV radiation-exposed rabbit corneas also was documented. A UV radiation glucose profile data indicate the presence of an active transport mechanism capable of delivering glucose into the corneal epithelium against a concentration gradient. The presence of a transport system that "pulls" glucose through the deeper corneal layers thus would make epithelium integrity important for the maintenance of overall corneal viability.

**89- 8. Human performance in continuous/sustained operations and the demands of extended work/rest schedules: An annotated bibliography Volume II.**  
June 1989. (ADA210504)

By Gerald P. Krueger and Suzanne M. Barnes.

A society intent upon maintaining high productivity levels 24 hours per day, and on providing a variety of services around the clock, produced occupations and circumstances requiring prolonged, continuous work periods. The performance of workers under conditions of sustained or continuous work has become an important topic in industrial psychology, and in particular, in the military sciences. There are some traditional jobs, circumstances, and even some new occupations that involve prolonged, sustained work periods without rest, in which individual workers continue beyond the normal 8-to-10 hour work day. In many of these sustained work situations, the termination point of the shift is unknown. Such activities usually require prolonged physical stamina and sustaining high levels of organizational and cognitive effectiveness. These continuous operations are of two types: First, there are extended operations, jobs, or tasks that proceed continuously with only a short break or breaks, but that operate within a typical shift system for lengthy periods, longer than a normal duty day. The worker knows he or she will be relieved or able to rest. Second, there are sustained operations, planned or unplanned, goal-oriented, nonstop continuous performance/operations without allowance for rest or sleep, in which the worker is expected to keep going as long as he or she can. Both have very important worker performance and behavioral implications.

Available research data on these topics are scattered through diverse printed sources, many of them difficult to locate. The second volume of the annotated bibliography lists 182 references containing research data, conceptual position

papers, and different methodological approaches to studying human performance in continuous/sustained operations and extended work/rest schedules. The time covered in the references is from 1940 to 1989 with a concentration on references printed between 1985 and 1989. Volume I, listing 399 references, was printed separately in 1985 at the Walter Reed Army Institute of Research. This Volume No. II also includes a cross subject index for the combined 582 references of both volumes.

**89- 9. Visual acuity and stereopsis with night vision goggles. June 1989.  
(ADA211552)**

By Roger W. Wiley.

Measurements of visual performance (stereopsis and visual resolution) were acquired to compare results achieved using unaided monocular and binocular viewing, monocular and binocular viewing with the AN/PVS-5 night vision goggles, and models A and B of the AN/PVS-7 biocular night vision goggles. All of the goggles were equipped with second generation tubes. Using a modified Howard-Dolman apparatus to assess stereopsis, all of the goggle-assisted thresholds were very much larger than stereoscopic thresholds achieved with unaided binocular vision. Statistical analysis of the results indicated that stereopsis through night vision goggles, regardless of the model or viewing condition, is essentially eliminated and equivalent to the threshold obtained with unaided monocular viewing. In comparison, spatial resolution capability with all of the goggle systems is superior to performance with unaided vision. In agreement with previously published data, visual acuity with the goggles is approximately 20/50, but only for high resolution targets and simulated full moon ambient light levels. As light levels decrease to quarter moon conditions or target contrasts are reduced to more realistic values, visual spatial resolution with the goggles is much poorer. Statistical analysis of the results indicates that a biocular night vision system causes no further visual penalty on stereopsis or visual acuity than binocular or monocular designs. For infantry use, any differences in visual performance among monocular, biocular, and binocular designs probably are not operationally meaningful.

**89-10. Visual survey of infantry troops, part I: Visual acuity, refractive status, interpupillary distance, and visual skills. June 1989. (ADA211456)**

By David J. Walsh.

The primary objective of the study was to establish a database characterizing the current visual status of infantrymen. Individuals selected as participants for this study were active duty personnel undergoing training to receive Military Occupational Specialty (MOS) 11B20, Infantryman. The visual survey test battery included measurements of visual acuity (high and low contrast), refractive error, interpupillary

distance, color vision, distance lateral phoria, stereopsis, contrast sensitivity, isoluminance resolution, and sighting dominance. This report represents data collected from the following tests/measurements: High contrast visual acuity, refractive error, interpupillary distance, depth perception, distance lateral phoria, and color vision. Of the 828 participants, 95.6 percent rated E-1 (highest classification) in the vision category of the physical profile serial. Among entry-level infantrymen, 33 percent were spectacle wearers. Distributions of the various visual parameters are presented for the test population and for selected subpopulations. Implications for selection/retention standards and for equipment design are discussed.

**89-11. Effects of ultraviolet radiation on the oxygen uptake rate of the rabbit cornea. (Reprint), July 1989. (ADA221535)**

By Morris R. Lattimore, Jr.

Ultraviolet radiation (UVR) has been demonstrated to be involved in a number of adverse ocular effects. One aspect of UVR-induced corneal stress only recently documented is an alteration of epithelial energy metabolite levels. In this study, in order to examine wavelength and dose dependency issues concerning metabolic effects on UVR, exposures were made at four different wavelengths (290, 300, 310, and 360 nm) and five different radiant exposures (0.05, 0.10, 0.15, 0.20, and 0.25 J. cm<sup>2</sup>). Pre- and postexposure levels of relative metabolic activity of the corneal epithelium were monitored in vivo by recording the corneal oxygen uptake rate with a micropolarographic electrode. A paired difference analysis demonstrated a decrease in relative corneal metabolic activity that was both wavelength- and dose-dependent. These relative metabolic effects provide some insight toward the understanding of underlying damage mechanisms, and imply a broader radiant energy susceptibility range of the eye than previously thought.

**89-12. Human factors and safety considerations of night vision systems flight. (Reprint), July 1989. (ADA211783)**

By Robert W. Verona and Clarence E. Rash.

Military aviation night vision systems greatly enhance the capability to operate during periods of low illumination. After flying with night vision devices, most aviators are apprehensive about returning to unaided night flight. Current night vision imaging devices allow aviators to flying during ambient light conditions which would be extremely dangerous, if not impossible, with unaided vision. However, the visual input afforded with these devices does not approach that experienced using the unencumbered, unaided eye during periods of daylight illumination. Many visual parameters, e.g., acuity, field-of-view, depth perception, etc., are compromised when night vision devices are used. The inherent characteristics of image intensification based sensors introduce new problems associated with the interpretation of visual

information based on different spatial and spectral content from that of unaided vision.

In addition, the mounting of these devices onto the helmet is accompanied by concern of fatigue resulting from increasing head supported weight and shift in center-of-gravity. All of these concerns have produced numerous human factors and safety issues relating to the use of night vision systems. These issues are identified and discussed in terms of their possible effects on user performance and safety.

**89-13. Evaluation of speech intelligibility through a bone-conduction simulator.**  
July 1989. (ADA212002)

By Ted L. Langford, Ben T. Mozo, and James H. Patterson, Jr.

The intelligibility of speech, delivered via a bone-conduction transducer, was measured under simulated combat vehicle noise conditions and compared with the same measurements made with a conventional, air-conduction system. The measurements were made for conditions in which the ear canals were open and in which they were occluded with protective earplugs. The use of bone-conduction systems led to a 25.3 dB improvement over the conventional, air-conduction system.

**89-14. Results of physiological monitoring from the 1985 P<sup>2</sup>NBC<sup>2</sup> tests at Fort Sill, Oklahoma.** July 1989. (ADB136703)

By Francis S. Knox, III, Glenn W. Mitchell, Ronald R. Edwards, and Michael G. Sanders.

Physiological data recorded during field tests of a 155mm self-propelled howitzer section in chemical protective gear are presented. Limitations to performance are documented and discussed in the context of the overall "Physiological and Psychological Effects of NBC and Sustained Operations in Combat Crews (P<sup>2</sup>NBC<sup>2</sup>) Program." Crewmen operating an M109 howitzer and associated M548 ammunition carrier while wearing MOPP 4 in average WBGT endured for a little over 2 hours.

Work in MOPP 4 leads to times to failure which are shorter than predicted by physiological measures alone. This suggests a psychological inability to cope with extreme conditions because of the associated discomfort. Potential fixes include individual and collective cooling systems to reduce the thermally-induced discomfort, as well as frequent crew rotation and rest. Avoiding or reducing direct solar loads may also be helpful.

**89-15. Effects of halothane anesthesia on blood cholinesterase activity in cats.**  
July 1989. (ADA212053)

By Albert W. Kirby, Alfred T. Townsend, Carolyn D. Pope, Robert G. Stafford, and Thomas H. Harding.

The effect of halothane anesthesia on blood cholinesterase activity was assessed in 24 adult cats. Blood samples were taken both before and during the course of halothane anesthesia. Acetylcholinesterase activity was depressed from 7 percent to 54 percent (average 19.5 percent) in 16 subjects, increased in 2 (9 percent and 11 percent), and was unchanged in the other 6. The mean acetylcholinesterase for the entire population was a 12.3 percent decrease. Pseudocholinesterase (butyrylcholinesterase) activity was depressed from 7 percent to 24 percent (average 12.2 percent) in 19 subjects, and was unchanged in the other 5. The mean butyrylcholinesterase depression for the entire population was 11 percent. There was no apparent correlation between the weight or gender of the animal, or the length of time on halothane, and the amount of depression in cholinesterase activity. Neither was there close agreement between changes in acetylcholinesterase and butyrylcholinesterase activity in a single cat. These results demonstrate that halothane has an inhibitory effect on blood cholinesterase activity in many cats (96 percent of those tested when counting either acetyl- or butyrylcholinesterase). The lack of agreement between changes in acetylcholinesterase and butyrylcholinesterase activity in the same animal suggests that the mechanisms may be different. It remains to be determined whether the amount of enzyme inhibition following halothane is functionally significant.

**89-16. Visual acuity with AN/PVS-5A night vision goggles and simulated flashblindness protective lenses under varying levels of brightness and contrast.** July 1989. (ADA212673)

By Richard R. Levine and Clarence E. Rash.

Flashblindness protection from tactical nuclear weapons is an issue of current concern in Army aviation. As a countermeasure, the Army is considering incorporating PLZT goggles/material into the overall design of the Aircrew Integrated Helmet System currently under development. Because present generation flashblindness material permit about 20 percent light transmission in the open state (about the same as the aviator's sunglasses), flying with PLZT under normal daylight conditions is not expected to impact aviator visual performance adversely. For night missions, PLZT would be used in conjunction with image intensification systems (e.g., night vision goggles [NVGs]). Placing PLZT between the NVG and the eyes would leave the sensitivity of the goggle to environmental lighting unaffected; however, the light available from the NVG could further degrade acuity (at best 20/50-20/60 with NVGs), a study was performed to determine the effects on visual acuity following an 80 percent reduction in goggle luminous output (e.g., from wearing

PLZT in its open state). The results of the study demonstrate that visual acuity with NVGs varies as a function of both ambient illumination and target contrast. However, there were no significant differences in acuity attributable to an 80 percent reduction in NVG output. While these results are encouraging, additional operational testing is required before deciding to incorporate PLZT or any other flashblindness protective material into the aviator's HGU-56/P.

**89-17. Effects of the chemical defense antidote atropine sulfate on helicopter pilot performance: A simulator study. July 1989. (ADA221255)**

By Ronald R. Simmons, John A. Caldwell, Robert L. Stephens, Lewis W. Stone, David J. Carter, Isaac Behar, Glenn W. Mitchell, Francis S. Knox, III, Heber D. Jones, and Philip L. Taylor.

Atropine is fielded as an antidote for organophosphate poisoning where chemical nerve agents are used. However, inappropriate self-injection may lead to anticholinergic side effects detrimental to aviators in flight. To determine the scope and magnitude of these possible side effects, 12 male Army helicopter pilots in good health flew several missions in a helicopter simulator after being injected (I.M.) with either a placebo or 2 mg or 4 mg of atropine sulfate. Physiological effects essentially followed the classic model. The 2 mg dose of atropine caused small degradations on some of the laboratory-collected measures, but often did not produce effects which differed significantly from those produced by a placebo dose. A 4 mg dose of atropine, however, exerted a variety of statistically significant effects upon flight performance, contrast sensitivity, cognitive performance, tracking accuracy, and cortical evoked responses. The flight performance evaluations (both subjective and objective) showed statistically significant changes in the subjects' abilities to fly the simulator. Results obtained from other tasks in the study suggest, further, the decrements in flight performance resulted from a slowing of both information and psychomotor performance. Atropine effects were not of sufficient magnitude to preclude further research under actual flight conditions.

**89-18. Evaluation of two objective measures of effective auditory stimulus level. August 1989. (ADA214669)**

By Ted L. Langford, Ben T. Mozo, and James H. Patterson, Jr.

The brainstem auditory evoked response and the 40-Hz component of the auditory midlatency response were measured in human subjects as a function of stimulus frequency and level to determine whether one of the two could be used to provide a reliable estimation of the amount of attenuation provided by hearing protective devices in situations in which the time available for measurement is restricted. Under the conditions of the present experiment, the variability of the

data for both types of measure was too great to permit a reliable estimation of effective stimulus level.

**89-19. Auditory evoked potentials as a function of sleep deprivation. (Reprint),  
September 1989. (ADA215119)**

By John Harsh and Pietro Badia.

Event-related brain potentials (ERPs) were studied in subjects deprived of sleep over a 48-hour test period to assess the effects of different durations of continuous wakefulness on ERP components and to determine whether changes in the ERP components were related to changes in performance. Forty subjects were randomly assigned to either an experimental (sleep deprived) group (n=30) or a control (not sleep deprived) group (n=10). For the experimental subjects, ERP and performance measures were obtained in 4-hour test blocks throughout the 48-hour period. Performance was assessed using the Walter Reed performance assessment battery. The control subjects were tested at the same times except during designated sleep periods. Both performance and evoked potential measures showed systematic changes over the experimental test period in association with sleep deprivation, time of day, and repeated testing. The latency of the N2 component of the evoked potential covaried with throughput measures on the performance assessment battery across the 12 4-hour test blocks of the experiment. These data suggest that ERPs reflect central processes that change across the sleep deprivation period and that ERP measures might be useful in assessment and prediction of performance degradation under adverse conditions such as sleep loss.

**89-20. Simulator sickness in the AH-1S (Cobra) flight simulator. September 1989.  
(ADA214562)**

By Daniel W. Gower, Jr., and Jennifer Fowlkes.

The U.S. Army Aeromedical Research Laboratory conducted field studies of operational flight simulators to assess the incidence and severity of simulator sickness. Simulator sickness here refers to the constellation of motion sickness related symptoms that occur in simulators due to visual representation, motion base representation, or combination of the two representations of flight. The incidence rates and relative frequency of specific symptoms are presented. Correlational factors such as recent simulator experience, current state of health, overall flight experience, mission scenario, and flight dynamics are presented. This report ranks the Army's flight simulators in comparison to the 10 Navy simulators studied by the Naval Training Systems Center, Orlando, Florida. The study further reinforces the need for studies to understand perceptual rearrangement, adaption/readaption, and pilot susceptibility to the effects of simulation. Design criteria for simulators, as well as those training guidelines necessary to cope with this phenomenon also must be

**89-21. A survey of U.S. Army aeromedical equipment. September 1989.  
(ADA214670)**

By Glenn W. Mitchell and James E. Adams.

Medical equipment is necessary to support patients requiring air transportation, but it may not be compatible with the aviation environment. Aircraft systems may cause errors in the functioning of medical equipment, or that equipment may be interfere with the aircraft. Medical equipment has been tested, primarily for fixed-wing aircraft, to military standards by the U.S. Air Force. This study reports 1986 and 1987 surveys which documents the use of such equipment on U.S. Army medical evacuation aircraft and compares items in current use to the U.S. Air Force's test results. Of the 115 different nonissue items reported in use, 32 have been formally evaluated, and 9 of those were judged unacceptable for use on aircraft. Only two items reported in the survey were tested in-flight in helicopters. The remaining 83 items have not been tested. Helicopters have unique requirements, and the U.S. Army has begun a program to evaluate medical equipment for helicopter use.

**89-22. Sustained work, fatigue, sleep loss and performance: A review of the issues.  
(Reprint), September 1989. (ADA215234)**

By Gerald P. Krueger.

The physiological and psychological stressors associated with sustained work, fatigue, and sleep loss affect worker performance. The review describes findings relating to sustained work stresses commonly found in our advancing technological world. Researchers report decrements in sustained performance as a function of fatigue, especially during and following one or more nights of complete sleep loss, or longer periods of reduced or fragmented sleep. Sleep loss appears to result in reduced reaction time, decreased vigilance, perceptual and cognitive distortions, and changes in affect. Sleep loss and workload interact with circadian rhythms in producing their effects. These interactions are a major source of stress in work situations requiring sustained work in continuous operations and have implications for theoretical models of sustained perceptual and cognitive functioning. This review highlights the research issues of 280+ members of the U.S. Department of Defense sponsored Human Factors Engineering International Technical Group on Sustained and Continuous Operations.

**89-23. Isoflurane anesthesia in the Octodon degus. September 1989. (ADA215492)**

By Jeffrey W. Record and Clarence E. Hargett, Jr.

Inhalation anesthesia for Octodon degus using isoflurane in a nonrebreathing system is described. Ten laboratory raised degus were used to determine the

optimum percentage of isoflurane to maintain surgical anesthesia. Time of loss of righting reflex, time of loss of toe pinch reflex, duration of surgical anesthesia and time to standing unaided were recorded. Findings indicate that 2 percent isoflurane with 1.5 liters per minute of both nitrous oxide and oxygen provide surgical anesthesia.

**89-24. Attenuating the luminous output of the AN/PVS-5A night vision goggles and its effects on visual acuity. September 1989. (ADA214895)**

By Richard R. Levine and Clarence E. Rash

Aviators in combat may be subjected to a variety of noxious light stimuli. Filters and other eye protective devices may be used to counter these threats. At night, filters may be used in conjunction with image intensification devices (e.g., night vision goggles) to provide useful low-light vision as well as protection from deleterious light sources (e.g., lasers, pyrotechnics, nuclear fireballs, etc.). Technologies may be combined in a single, integrated head gear unit. The present study was performed in order to consider the effects on visual acuity after reducing night vision goggle luminous output from 0-99 percent. A range of target contrasts and ambient illumination levels was investigated. AN/PVS-5A goggles were selected based upon their compatibility with current phosphor display technology and their current ubiquity within aviation units. Visual acuity was assayed behaviorally because of its critical importance in flying performance. The results of the study provide normative acuity data with goggles alone and document the effects on goggle visual acuity with reduced goggle luminances as might be produced by protective materials placed between the goggles and the eyes.

**89-25. Simulator sickness in the UH-60 (Black Hawk) flight simulator. September 1989. (ADA214434)**

By Daniel W. Gower, Jr., and Jennifer Fowlkes.

The U.S. Army Aeromedical Research Laboratory conducted field studies of operational flight simulators to assess the incidence and severity of simulator sickness. Simulator sickness here refers to the constellation of motion sickness related symptoms that occur in simulators due to visual representation, motion base representation, or combination of the two representations of flight. The incidence rates and relative frequency of specific symptoms are presented. Correctional factors such as recent simulator experience, current state of health, overall flight experience, mission scenario, and flight dynamics are presented. This report ranks the Army's flight simulators in comparison to the 10 Navy simulators studied by the Naval Training Systems Center, Orlando, Florida. The study further reinforces the need for studies to understand perceptual rearrangement, adaption/readaption, and pilot susceptibility to the effects of simulation. Design criteria for simulators, as well as

those training guidelines necessary to cope with this phenomenon also must be addressed.

**89-26. Effects of ultraviolet radiation on the oxygen uptake rate of the rabbit cornea. (Reprint), September 1989. (ADA214558)**

By Morris R. Lattimore, Jr.

Ultraviolet radiation (UVR) has been demonstrated to be involved in a number of adverse ocular effects. One aspect of UVR-induced corneal stress only recently documented is an alteration of epithelial energy metabolite levels. In this study, in order to examine wavelength and dose dependency issues concerning metabolic effects of UVR, exposures were made at four different wavelengths (290, 300, 310, and 360 nm) and five different mean radiation exposures (0.05, 0.10, 0.15, 0.20, and 0.25 J.c-2). Pre- and postexposure levels of relative metabolic activity of the corneal epithelium were monitored in vivo by recording the corneal oxygen uptake with a micropolarographic electrode. A paired difference analysis demonstrated a decrease in relative corneal metabolic activity that was both wavelength- and dose-dependent. These relative metabolic effects provide some insight toward the underlying damage mechanisms, and imply a broader radiant energy susceptibility range of the eye than previously thought.

**89-27. Evaluation of helmet retention systems using a pendulum device. September 1989. (ADA215489)**

By Peter Vyrnwy-Jones, Charles R. Pascal, and Ronald W. Palmer.

Three methods were evaluated for testing the retention and rotation characteristics of aircrew helmets. Two of these employed static techniques with an anthropometric headform and human subjects. Unfortunately, though simple in execution, these tests were insensitive to the mass and mass distribution of the helmets. However, the third method, the pendulum beam Department of Transportation testing device proved to be a simple and efficient means of differentiating between the various helmets. This method should have a role in the development and testing of future U.S. Army aircrew helmets.

**89-28. Simulator sickness in a CH-47 (Chinook) flight simulator. September 1989. (ADA218214)**

By Daniel J. Gower, Jr., Jennifer Fowkles, and Dennis R. Baltzley.

The U.S. Army Aeromedical Research Laboratory conducted field studies of operational flight simulators to assess the incidence and severity of simulator

sickness. Simulator sickness here refers to the constellation of motion sickness related symptoms that occur in simulators due to visual representation, motion base representation, or combination of the two representations of flight. The incidence rates and relative frequency of specific symptoms are presented. Correctional factors such as recent simulator experience, current state of health, overall flight experience, mission scenario, and flight dynamics are presented. This report ranks the Army's flight simulator in comparison to the 10 Navy simulators studied by the Naval Training Systems Center, Orlando, Florida. The study further reinforces the need for studies to understand perceptual rearrangement, adaption/readaption, and pilot susceptibility to the effects of simulation. Design criteria for simulators, as well as those training guidelines necessary to cope with this phenomenon also must be addressed.

89-29. **Descriptive analysis of medical attrition in U.S. Army aviation.** (Reprint), August 1989. (ADA219489)

By Ronald J. Edwards and Dudley R. Price.

Although U.S. Army aviators are carefully screened at entry, disease develops in the aviator population with time. Improving the ability to predict and prevent such diseases necessitates proper analysis of their incidence. This information can provide the basis for future improvements in screening and prevention. A descriptive analysis of diseases for the U.S. Army aviation population is presented. The frequency of International Classification of Diseases (ICD) codes leading to disqualification from flying status is summarized and discussed. Suggestions for future screening criteria and for intervention practices are proposed.

89-30. **Problem oriented differential diagnosis of tropical diseases.** September 1989. (ADA218949)

By Kevin T. Mason.

A problem oriented differential diagnosis of tropical diseases was written for primary care physicians. The text describes the basic principles of travel medicine, survival in the tropics, and heat injury. Tables organizing the incubation period and geographic distribution of tropical diseases are provided. The remaining text discusses tropical diseases organized by organ system, signs, and symptoms. The purpose is to assist primary care physicians in arriving at a limited differential diagnosis of tropical diseases before consulting tropical medicine texts and initiating empiric therapy and diagnostic workup.

## **Fiscal Year 1990**

**90- 1. Six-month evaluation of extended wear soft contact lenses among armored troops: Part I: Clinical findings. (Reprint), December 1989. (ADA219282)**

By William G. Bachman, Bruce C. Leibrecht, John K. Crosley, Dudley R. Price, Patrick M. Leas, and Gerald A. Bentley.

This report addresses the clinical aspects of wearing contact lenses in an operational military environment. Male volunteers in an armored division wore extended-wear soft contact lenses (SCLs) or spectacles for up to 6 months, participating fully in their units' normal activities. Seventy-four percent of those successfully fitted with SCLs wore their lenses for the duration of the study, when administrative losses were factored out. More than one-third of the SCL wearers experienced one or more ocular conditions requiring at least a temporary suspension of lens wear. Corneal edema and corneal staining occurred rarely at clinically significant levels. Higher than expected rates of corneal vascularization were most likely influenced by measurement criteria. Relatively frequent conjunctival injection appeared to be largely due to local environmental factors.

**90- 2. Six-month evaluation of extended-wear soft contact lenses among armored troops: Part II: Subjective responses by patients. (Reprint), December 1989. (ADA220169)**

By Bruce C. Leibrecht, William G. Bachman, John K. Crosley, Dudley R. Price, Patrick M. Leas, and Gerald A. Bentley.

This report addresses subjective patient responses to wearing contact lenses in an operational military environment. Male volunteers in an armored division wore extended-wear soft contact lenses (SCLs) or spectacles for up to 6 months, participating fully in their units' normal activities. Responding to end-of-study questionnaires, most of the SCL wearers believed that they could see better with their SCLs than with spectacles. The great majority indicated contact lenses had improved their overall performance, preferring SCLs for a variety of military activities. SCL-related environmental difficulties were reported frequently for conditions involving dust, wind, and smoke, whereas spectacle-related problems were common especially in the case of rain, dust, hot weather, or high humidity. Problems reported with handling and cleaning corrective lenses were more common among spectacle wearers than among SCL wearers.

**90- 3. Laser protection with image intensifier night vision devices. February 1990.  
(ADA220893)**

By David J. Walsh.

Current military ranging and targeting technology employs high power laser systems. Since coherent (laser) energy with wavelengths in the visible and near infrared can seriously damage the retina of the eye, laser retinal injury has been the subject of man studies. The results of these investigations are used by various agencies to recommend laser eye protection. In the aviation community, since laser protection helmet visors are not compatible with most common night vision devices (NVDs), i.e., AN/PVS-5 Night Vision Goggle (NVG) and Aviator's Night Vision Imaging System (ANVIS), the only laser protection currently afforded the NVD aviator is a barrier-type protection provided by the device.

Based on eye anatomy and function, three retinal zones have been identified as critical to protect -- fovea, macula and peripapillary zones (1 to 2 degree annulus surrounding the optic disc). When full-coverage laser protection is not possible, minimum acceptable coverage must include these regions. A circular area which includes the critical regions would cover the central retina, i.e., area out to 25 degrees from the visual axis.

During ANVIS use, coverage exceeds the recommended 25 degree minimum, but only when the eyes are in the primary (straight ahead) position. With normal scanning eye movement, critical areas of the retina become exposed to laser damage. Continuous laser protection for the central retina, out to 25 degrees, will require either a mechanical obstruction or a laser protective spectacle or visor which covers at least 90 degrees. The mechanical laser protection provided by NVD wear alone is only adequate to protect the aviator.

**90- 4. The effect of pyridostigmine and physostigmine on the neural portion of the visual system. February 1990. (ADA221053)**

By Albert W. Kirby and Alfred T. Townsend.

Carbamates are currently the pretreatment drugs of choice for protection against possible nerve agent exposure. Pyridostigmine does not cross the blood-brain barrier easily, and therefore provides no central protection. Physostigmine readily enters the central nervous system, but as might be expected, has strong central effects. These experiments were done to access the role of pyridostigmine and physostigmine on visual processing in a mammalian animal model. The results show that physostigmine has strong central visual effects which operationally would not be acceptable. Pyridostigmine does not enter the central nervous system after acute administration until very high levels of cholinesterase inhibitors are reached. Based upon our limited sample, central visual processing appears not to be affected until inhibition

of blood cholinesterase approaches 80 percent. This should provide an adequate safety margin following pretreatment with pyridostigmine. We did not investigate the effect of chronic low dose pyridostigmine administration on sensory processing.

**90- 5. Health hazard assessment primer. February 1990. (ADA220953)**

By Bruce C. Leibrecht.

This primer provides an introductory orientation to the Health Hazard Assessment program supporting the U.S. Army's materiel acquisition efforts. The description of types and effects of health hazards includes an inventory of those hazards commonly encountered in Army systems. Substantial text outlines the organizations and processes comprising the HHA system, along with an explanation of how the system is designed to work. A conceptual framework characterizes the steps involved in preparing a HHA report. A final section describes the program contributions made by HHA-related research and the organizations performing pertinent research. Supplemental materials include a summary of the Army's life cycle system management model, a listing of HHA points of contact, and a brief description of risk assessment codes.

**90- 6. Evaluation of the head injury hazard during military parachuting. March 1990. (ADA220724)**

By Charles R. Pascal, Jr., Ronald W. Palmer, Dennis F. Shanahan, and Joseph L. Haley, Jr.

The incidence of head injury during U.S. Army airborne training and airborne operations has doubled in recent years. A number of factors are known to contribute to head injuries incurred during airborne training/operations. These factors include the small amount of impact protection provided by the PASGT helmet, shortcomings in training procedures, and failure of trained airborne troops to follow proper procedures when jumping. Other factors are involved as well. This report shows, with relatively little modification, the impact protection and retention characteristics of the PASGT airborne helmet can be significantly improved. Also, this report evaluates a number of factors present in airborne training and operational environments that contribute to head injury and explains how training and operational procedures can be modified to reduce the incidence of repeated headstrikes and subsequent serious head injuries.

**90- 7. Reduction of variance in expert panel estimates of U.S. Army combat vehicle crew endurance. March 1990. (ADA220801)**

By Glenn W. Mitchell and Francis S. Knox, III.

An expert panel was assembled to explore the effectiveness of a novel method for reducing the variance of face-to-face group estimates. The panel's task was to estimate the effects of selected physiological and psychological variables on Army aviation and armor combat vehicle crews during representative combat missions. These missions were considered separately for two levels of individual protective equipment. The ESTIMATE-TALK-ESTIMATE method with an impartial group facilitator was used to control the process. The results from the panel demonstrated the effectiveness of this face-to-face, consensus-based method for reducing the variance of their combined estimates. The overall mean percentage reduction of the coefficient of variance was  $39.8 \pm 0.8$  percent. The panel compiled an exhaustive list of parameters required for collection during military field tests to facilitate integration and comparison in future databases. The panel also developed a list of specifications of an accurate predictive model of the physiological and psychological limitations on U.S. Army combat vehicle crew endurance.

**90- 8. Development of a ruggedized hand-held computer for performance testing in operational settings. March 1990. (ADA229421)**

By John A. Caldwell, Jr., and Craig Young.

Portable, ruggedized computers, capable of administering standard automated tests under harsh environmental conditions, have been needed by researchers for many years. Particularly, military psychologists require tools which will permit the testing of soldiers during operationally-relevant field exercises without problems of equipment malfunctions. In 1984, the U.S. Army Medical Research and Development Command sought to address this requirement by sponsoring a Small Business Innovative Research (SBIR) effort with Paravant Computer Systems, Inc. The SBIR resulted in the design and construction of the RHC-88, a notebook-sized, MS-DOS-based, IBM compatible computer which offers extensive programming flexibility in a portable, expandable, field-hardened unit. With the RHC-88, now it is possible to administer a wide variety of computer-based tests in the laboratory and in the field.

**90- 9. Development of an improved SPH-4 retention system. April 1990. (ADA222935)**

By Robert H. Hines, Ronald W. Palmer, Joseph L. Haley, Jr., and Ernest E. Hiltz.

Impact protection during a crash is one of the primary functions of a flight

helmet. In order for the helmet to provide effective impact protection, the helmet must remain firmly secured on the head for the entire duration of the crash sequence. If the helmet is displaced on the head or comes off the head during the crash sequence, cranial exposure and subsequent head injury can occur. Previous research at USAARL has shown the retention assembly of the SPH-4 flight helmet often allows excessive helmet rotation or even helmet loss to occur during a crash. This report describes the construction and testing of a new SPH-4 retention assembly, the USAARL yoke harness, which will alleviate the helmet rotation/ helmet loss problem. The load versus elongation under load and comfort of the USAARL yoke harness was compared to that of the currently used standard retention harness. The USAARL yoke harness was stronger, stretched less under load than the standard retention harness. Comfort testing of the USAARL showed the majority (72 percent) of those questioned preferred the USAARL yoke harness over the standard harness.

**90-10. Human factors and safety considerations of night vision systems flight using thermal imaging systems. (Reprint), April 1990. (ADA223226)**

By Clarence E. Rash, Robert W. Verona, and John S. Crowley.

Military aviation night vision systems enhance the aviator's capability to operate effectively during periods of low illumination, adverse weather, and in the presence of obscurants. Current fielded systems allow aviators to conduct terrain flight during conditions which would be extremely dangerous, if not impossible, using only unaided vision. In night vision systems, trade-offs are made that enhance some visual parameters and compromise others. Examples of visual parameters which are traded off include acuity, field-of-view, spectral sensitivity, and depth perception. Cost, weight, and size constraints also lead to compromises between an ideal and a viable system design. Thermal imaging sensors introduce enhanced night vision capabilities along with new problems associated with the interpretation of visual information based on spectral and spatial characteristics differing from those provided by unaided vision. In addition, the mounting of these visual displays onto the aviator's helmet provokes concern regarding fatigue and crash safety, due to increased head-supported weight and shifts in center-of-gravity. Human factors and safety issues related to the use of thermal night vision systems are identified and discussed. The accumulated accident experience with U.S. Army AH-64 helicopters equipped with the thermal Pilot's Night Vision System and the Integrated Helmet and Display Sighting System is briefly reviewed.

**90-11. Visual processing: Implications for helmet mounted displays. (Reprint), May 1990. (ADA223488)**

By Jo Lynn Caldwell, Rhonda L. Cornum, Robert L. Stephens, and Clarence E. Rash

A study was conducted to compare the performance of AH-64 (Apache) pilots

to other Army pilots on visual tasks. Each pilot was given a task presented monocularly to the right eye, a task presented monocularly to the left eye, and a task presented to both eyes simultaneously in a dichoptic task. Results indicated no performance difference between the group of pilots on the dichoptic task, but indicated better performance on the left monocular task for the AH-64 pilots. These results indicate that AH-64 pilots who are required to switch their attention from their left eyes to their right eyes in order to obtain needed information are capable of processing information efficiently and effectively using only one eye. The implications of these results for the Integrated Helmet and Display Sighting System (IHADSS) are discussed.

**90-12. Visual performance of contact lens-corrected ametropic aviators with the M-43 protective mask. May 1990 (ADA224915)**

By Richard R. Levine, Morris R. Lattimore, and Isaac Behar.

The present study investigated the use of extended wear soft contact lenses with the Apache aviator's M-43 protective mask. Visual functions tests (high and low contrast visual acuity, contrast sensitivity, color vision), visually-based cognitive tests, and user-comfort questionnaires were employed with normally sighted aviators and with aviators fitted with hydrogel soft contact lenses. Tests were administered shortly before donning the mask, immediately after donning the mask, and at hourly intervals, over the course of the next 4 hours of continuous mask wear. Physiological function (tear break-up time, tear production, slit lamp examination) was assessed before donning the mask and directly after its removal. The results of the study indicated, for some subjects in both groups, the presence of subjective discomfort (from the M-43's airflow around the eyes) and mildly increased conjunctival injection ("redness"). However, no significant changes in visual function, cognitive performance, or physiological function were observed in either group as a result of wearing the mask. The data confirm previous work indicating acceptable visual performance with the M-43 mask and indicate that extended wear soft contact lenses can be worn with the M-43 protective mask with degrading selected aspects of visual performance.

**90-13. Prevalence of spectacle wear among U.S. Army aviators. August 1990. (ADA227583)**

By Robert H. Schrimsher and Morris R. Lattimore.

The advanced avionic and electro-optical systems installed within Army rotary-wing aircraft are becoming increasingly incompatible with spectacle wear. Therefore, the prevalence of spectacle wear among Army aviators is an important factor to take into account in the development of future systems. A review of spectacle prevalence data within the Aviation Epidemiology Data Register (AEDR) for the years 1986, 1987, 1988, and 1989 was performed. Data were consistent across all 4 years, with

mean prevalence of spectacle wearing being 22.25 percent for active component forces. Over the same 4-year period, Reserve and National Guard forces displayed mean spectacle-wear prevalences of 27 percent and 32 percent, respectively. These prevalence rates are higher than those previously obtained in 1985 by a similar but slightly different paradigm. The prevalence of presbyopic aviators by this query is also higher than previous appraisals. In conclusion, spectacle-wearing aviators exist in greater numbers than previously documented, and represent a segment of the aviation population that will have increasing compatibility problems with advanced flight systems. Therefore, system planners will need to address these incompatibilities in future hardware developments.

**90-14. Circadian rhythm desynchronosis, jet lag, shift lag, and coping strategies.**  
(Reprint), September 1990. (ADA288787)

By Carlos A. Comperatore and Gerald P. Krueger.

Jet lag and shift lag have similar physiological consequences, but shift lag is a more complex problem. The most severe desynchronization may be experienced by airline personnel making transmeridian flights. Coping strategies for eastward and westward travelers and for shiftworkers are recommend, as are interventions involving melatonin.

**90-15. Visual survey of Apache aviators (VISAA).** September 1990. (ADA230201)

By Isaac Behar, Roger W. Wiley, Richard R. Levine, Clarence E. Rash, David J. Walsh, and Rhonda L. S. Cornum.

A three-part study was conducted to assess the visual status of AH-64 pilots. The first part consisted of an anonymous questionnaire returned by 58 Fort Rucker instructor pilots. More than 80 percent of the pilots registered at least one visual complaint (visual discomfort, headache, double vision, blurred vision, disorientation, or afterimages) associated with flying or after flying the Apache aircraft. Many of their comments indicated that symptoms occurred during long flight and/or flying with poor quality or out-of-focus display symbology.

In the second part of this study, a comprehensive visual function test battery was completed on 10 volunteer, highly experienced AH-64 pilots. The visual function testing included assessments of visual acuity, contrast sensitivity, color vision, depth perception, sighting preference, binocular rivalry, and clinical optometric tests of manifest and cycloplegic refractions, accommodative function, and oculomotor status. None of these measures related to a visual complaint index. Differences between the left and right eye were small in all cases. There was evidence of mild incipient presbyopia in many of the pilots, but this is within expectations for the age group (32 to 44 years). Binocular ocular motility for the group as a whole was found to be lower than expected.

In the third part of this study, measurements were made on the flight line of the Helmet Mounted Display diopter focus settings made by Apache IPs and students. The diopter settings ranged from 0 to -5.25 with a mean of -2.28. The re-quired positive accommodation by the eye to offset these negative focus settings is very likely a source of visual discomfort and headache during and after long flights.

### **Fiscal Year 1991**

**91- 1. Effect of vibration frequency and acceleration magnitude of chicken embryos on viability and development phase I. November 1990. (ADA231723)**

By Linda C. Taggart, Nabih M. Alem, and Helen M. Frear.

There is little known about the effect of vibration on developing embryos. The feasibility of developing an avian model to study this effect was established for this study. One hundred chicken eggs were divided into four trays of 25 each and exposed to vibration of 1 Hz 0.25 G, 5 Hz 3 G, 10 Hz 3 G, and a control of no vibration. Hatch rate was 0 percent for 5 Hz, 12 percent of 10 Hz, and 89 percent of the 1 Hz eggs that did not crack during the incubation period. The control hatch rate was 84 percent.

**91- 2. Test and evaluation report of the Laerdal suction unit. December 1990. (ADA235647)**

By Jeffrey D. Haun, Joseph R. Licina, Bill Olding, Randall Thomas, Larry C. Woodrum, and Helen M. Frear.

The Laerdal suction unit was tested for electromagnetic interference/ compatibility in the UH-60A helicopter under the U.S. Army Test and Evaluation of Aero-medical Equipment Program. The tests were conducted using current military and industrial standards and procedures for electromagnetic interference/compatibility and human factors. The Laerdal suction unit passed the overall evaluation and is validated as compatible with U.S. Army aeromedical aircraft.

**91- 3. Contact lenses in the U.S. Army attack helicopter environment: An interim report. December 1990. (AD4232373)**

By Morris R. Lattimore.

Recent technological advantages have had a major impact on military aviation. While modern methods of providing visual information via electro-optics/visionics systems have extended the aviator's operational envelope, these devices are becoming increasingly incompatible with spectacle wear. Since approximately 20 percent of Army aviators are ametropic (spectacle wearing), alternative means of providing

a refractive error correction need to be investigated. One alternative being considered is the use of a contact lens correction.

For the past year, the U.S. Army Aeromedical Research Laboratory (USAARL) has been conducting a worldwide, AH-64 "Apache" contact lens research project in order to develop a comprehensive database on contact lens wear in a variety of environments. A three-tier contact lens fitting system is being used: two different types of soft lens and one rigid gas permeable (RGP) lens type. The wearing schedule is set at a maximum of 7 days/6 nights of extended lens wear. Fundamental operational data is being chronicled by unit flight surgeons. Standard clinical data is being used in ongoing command deliberations on future medical policy decision concerning contact lens wear by aviators. Basic research information is being gathered in a effort to determine the fundamental physiological response of the cornea to the presence of a contact lens.

The subjective assessment of contact lens applications within the aviation community is universal acceptance. While current clinical data indicate some ocular health risk, flight safety risks are minimal. Establishment of long-term contact lens efficacy likely will depend on the ensuing analysis of physiological data.

**91- 4. Coding manual for the U.S. Army aviation epidemiology data register.** January 1991. (ADA231885).

By Thomas J. Burke and Renee Kingsley.

The U.S. Army Epidemiology Data Register (AEDR) is an automated database which allows electronic storage, analysis, and retrieval of information of the Flying Duty Medical Examination (FDME). The FDME consists of a completed Report of Medical History standard for (SF 93), Report of Physical Examination (SF 88), Report of Electrocardiogram (SF 520) with the electrocardiogram tracing, and for certain classes of FDME, additional information on lifestyle factors and family history. Demographic data, patient history, physician history, physical findings, screening tests, and diagnoses information are included on these forms, each of which has a unique value in health care, administration, and research, and each of which must be handled differently in the AEDR. Demographic and screening test results are entered directly from the FDME to the AEDR. History, physical findings, and diagnosis are translated into a standardized alphanumeric code, a modification of the International Classification of Diseases (ICD). Because of the unique characteristics of the military aviation environment, the ICD is inadequate to support all the clinical, administrative, and research functions of the AEDR. The ICD has been supplemented with additional diagnostic codes to provide extra specificity, codes for physical findings and electrocardiogram, and codes to automate the administrative process. The codes are presented and discussed.

**91- 5. A test of the American Safety Flight Systems, Inc. prebreather/portable oxygen system. January 1991. (ADA232723)**

By Robert L. Stephens, Francis S. Knox, III, Robert A. Mitchell, and Vadankumar M. Patel.

In response to a request from the Aviation Life Support Equipment Product Manager (ALSE-PM) of the Aviation Systems Command (AVSCOM), the U.S. Army Aeromedical Research Laboratory (USAARL) conducted an investigation and evaluation of the Prebreather/Portable Oxygen System (P/POS) manufactured by American Safety Flight Systems, Inc.

A test of the P/POS was conducted in the hypobaric chamber of the U.S. Army School of Aviation Medicine. Four crews of four subjects each and one crew of three (the last crew had only three because one subject had a middle ear infection) pre-breathed 100 percent chamber oxygen for 30 minutes. Then they switched to the P/POS while the chamber was depressurized to 18,000 feet MSL at a rate of 500 fpm. They remained at this altitude pressure until they reduced the P/POS pressure from 1800 psi to 200 psi. Following this, the chamber was repressurized to sea level at a rate of 4000 fpm.

Mission duration, percent oxygen saturation, and cognitive performance were measured for each subject. The average mission duration was 2 hours 28 minutes with a standard deviation of 13.9 minutes. If the P/POS pressure had been allowed to drop to 50 psi, the projected average mission duration for a crew of four would have been 2 hours 42 minutes (assuming minimal workload). All subjects were well oxygenated during the entire chamber session as demonstrated by percent saturation readings which rose from 97 percent to 99 percent during prebreathing and remained at 99 percent while subjects breathed from the P/POS. Cognitive performance data suggested no serious decrements in subjects' mental abilities during the chamber session.

The study indicated the P/POS will meet the needs of all helicopter missions for the Army that do not require prebreathing. Missions to altitudes which require prebreathing are extremely rare, but could be accomplished with the addition of a second system connected to the dilution port.

**91- 6. The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the co-pilot/gunner, volume I. January 1991. (ADA233349)**

By Nabih M. Alem, Dennis F. Shanahan, John V. Barson, and William H. Muzzy, III.

Accident investigation records of U.S. Army helicopter crashes show injuries of pilots due to striking a structure inside the cockpit outnumber those due to excessive

accelerations by a five-to-one ratio. The two-volume report presents the results of a study of the effectiveness of airbags in reducing the severity of contact injury to the gunner when striking the gunsight. Airbag systems were installed on the gunsights in simulated Cobra and Apache cockpits, then sled tested at 7 and 25 G.

The tests indicated airbags reduced head accelerations by 65 percent, head injury criteria by 77 percent, and head angular acceleration by 76 percent in the Cobra tests. In the Apache tests, the airbags reduced these same indicators by 68, 52, and 83 percent. An airbag system, the report concludes, is likely to prevent severe or fatal head and chest injuries in an Apache or Cobra crash. Volume I of the report describes the tests and discusses the results. Volume II consists of Appendixes A, B, and C of the report and contained processed signal graphs of all sled tests. Volume II is available upon request from SIC, USAARL.

**91- 6. The airbag as a supplement to standard restraint systems in the AH-1 and AH-64 attack helicopters and its role in reducing head strikes of the co-pilot/gunner, volume II. January 1991. (ADA232907)**

By Nabih M. Alem, Dennis F. Shanahan, John V. Barson, and William H. Muzzy, III.

Accident investigation records of U.S. Army helicopter crashes show injuries of pilots due to striking a structure inside the cockpit outnumber those due to excessive accelerations by a five-to-one ratio. The two-volume report presents the results of a study of the effectiveness of airbags in reducing the severity of contact injury to the gunner when striking the gunsight. Airbag systems were installed on the gunsights in simulated Cobra and Apache cockpits, then sled tested at 7 and 25 G.

The tests indicated airbags reduced head accelerations by 65 percent, head injury criteria by 77 percent, and head angular acceleration by 76 percent in the Cobra tests. In the Apache tests, the airbags reduced these same indicators by 68, 52, and 83 percent. An airbag system, the report concludes, is likely to prevent severe or fatal head and chest injuries in an Apache or Cobra crash. Volume I of the report describes the tests and discusses the results. Volume II consists of Appendixes A, B, and C of the report and contains processed signal graphs of all sled tests.

**91- 7. Concept evaluation of the UH-60 externally mounted rescue hoist. January 1991. (DTIC number being assigned)**

By Joseph R. Licina, Larry C. Woodrum, and Douglas P. Pritts.

The concept evaluation of an Externally Mounted Rescue Hoist (EMRH) was performed with the Breeze Eastern EMRH installed on an U.S. Army UH-60 helicopter. A comparative analysis was conducted between the EMRH and the Internally Mounted Rescue Hoist (IMRH) which assessed initial inspection, physical

characteristics, installation, and compatibility with the aircraft, performance, and safety. The EMRH showed significant improvement over the IMRH currently used in U.S. Army MEDEVAC aircraft.

**91- 8. Military aviation: A contact lens review. (Reprint), January 1991.  
(ADA233199)**

By Morris R. Lattimore.

The military aviation communities have benefitted from the development of advanced electro-optical avionics systems. One drawback that has emerged is an increasing system incompatibility with traditional spectacle visual corrections. An alternative solution to the refractive error correction problem that some services has been investigating is that of contact lens wear. Since this much-debated topic is currently of command interest, a general overview of contact lens issues is presented as a framework for future discussions.

**91- 9. Conspicuity comparison of current and proposed U.S. Army wire marker designs. February 1991. (ADA233518)**

By Richard R. Levine, Clarence E. Rash, and John S. Martin.

In-flight wire strikes are a serious threat to U.S. Army aviation during all-weather daytime and nighttime helicopter operations. To reduce this threat, the aviation training community employs a passive marking system for increasing the conspicuity of high tension cables, electrical power lines, and telephone wires. This system uses international-orange fiberglass spheres having a diameter of approximately 11.5 inches and utilizing various conspicuity enhancing schemes. These spheres are attached to the cables and wires at locations heavily used by aircraft. In this study, the conspicuity of the basic and proposed modified designs were investigated as a function of background, illumination level (for both day and night with weather effects), sun (or other bright source) angle, and viewing system (e.g., unaided eye, thermal sensor, or image intensifier). While no differences among designs were observed under daylight conditions, improved performance under several viewing/lighting conditions was observed for two retroreflective polyhedron designs under typical aircraft lighting conditions at night. Increased detection ranges were noted both with and without image intensification devices and under aircraft lighting conditions characteristic of the local aviation training environment.

**91-10. Ultraviolet radiation effects on the corneal epithelium. February 1991.  
(ADA233011)**

By Morris R. Lattimore.

Since military troops are involved in extensive outdoor activities with chronic

exposure to solar radiation, and since ultraviolet radiation (UVR) lasers may play a role in the future military environment, a thorough understanding of UVR damage mechanisms would be crucial to the development of intervention and treatment modalities. The present research was directed at quantifying possible alterations in corneal epithelial metabolic activity secondary to in vivo exposure to UVR in the rabbit.

A 5,000 watt Hg-Xe arc lamp served as the UVR source. The radiant exposures were kept constant at 0.05 J.cm<sup>-2</sup> for all UVR wavelengths used (290, 300, 310, and 360 nm). Wavelength isolation was accomplished with a double monochromator providing a 6 nm full bandpass. The four experimental wavelengths were chosen based on an interest in maintaining an environmental relevance, since 290 nm UVR and above can be found at the earth's surface. Micropolarographic measurement of corneal oxygen uptake rates served as an in vivo index of UVR-induced effects on oxidative metabolism. Microfluorometric analyses of key epithelial energy metabolites (glucose, glycogen, ATP, and PCr) were used as an in vivo index of UVR-induced effects on overall metabolic activity. A paired difference analysis of the oxygen uptake rate data demonstrated a decrease in relative corneal oxidative metabolic activity that was wavelength-dependent. These same experimental UVR exposure conditions served to significantly increase epithelial glucose and glycogen concentrations. Although the epithelial ATP concentrations were unchanged, the epithelial PCr concentrations (a high energy phosphate bond reservoir) decreased as a result of UVR exposure.

These data demonstrate a decrease in corneal epithelial oxidate metabolic activity as a result of UVR exposure, and infer an adverse effect on glycolytic metabolism, as well. It is suggested that immediate UVR-induced metabolic inhibitory effects can be responsible for the pattern of epithelial cell loss seen in photokeratitis.

91-11. **SPH-4 aircrew helmet impact protection improvement 1970-1990.** February 1991. (ADA233784)

By Ronald W. Palmer.

The Sound Protective Helmet-4 (SPH-4), a derivative of the Navy SPH-3, has been used by the Army since 1970. As our knowledge of crash environments and human impact tolerance has increased through analyses of aircraft accidents and laboratory research, the performance of the standard SPH-4 helmet has been continuously reappraised, and the helmet's shell, liner, retention, earcups, and suspension have been upgraded to provide more impact protection. This report includes a discussion of improvements made in the SPH-4 helmet and the effects these improvements have had on its performance. The SPH-4, SPH-4B, and HGU-56/P are compared in terms of major design features, impact protection, and retention capabilities. The development of helmet impact testing methodology used at the U.S. Army Aeromedical Research Laboratory, Fort Rucker, Alabama, also is discussed.

**91-12. Contact lens anterior surface pH.** (Reprint), February 1991. (ADA233252)

By Morris R. Lattimore.

Recent reports of CO<sub>2</sub> accumulation under hydrogel lenses, paired with the detection of a decrease in stromal pH following contact lens wear, have highlighted the potential for tear pH assessment as a clinical tool. The in situ anterior hydrogel lens surface pH was measured with a flat-surfaced, self-referenced pH electrode in order to indirectly evaluate fluid exchange between the precorneal tear film and hydrogel lenses. Volunteer human subjects were fitted with moderate water content (58%), disposable extended wear hydrogel lenses. Measurements were recorded from the lens in its packaged stage (pH 6.99), from the lens in situ 5 minutes after initial lens application (pH 7.17), 24 hours later (pH 7.34), and at the end of 7 days continuous contact lens wear (pH 7.43). Possible cornea-tear film-hydrogel lens interactions could explain certain hydrogel lens-associated contrast sensitivity deficits and transient endothelial changes.

**91-13. Visual and field-of-view evaluation of the M-43 protective mask with prescription eyepieces.** March 1991. (ADA234592)

By John K. Crosley, Clarence E. Rash, and Richard R. Levine.

The U.S. Army Aeromedical Research Laboratory was requested by the proponent of the M-43 aviator protective mask to conduct a laboratory study of the visual performance of eight AH-64 Apache helicopter pilots wearing masks with "glue-on" prescription lenses. In response, several visual functions tests were conducted including: high and low contrast visual acuity, heterophoria, fixation disparity, and stereopsis at both near and far. In addition, visual field losses of the Integrated Helmet and Display Sighting System were examined. Performance in the corrective mask was compared to that with habitual correction, either spectacles or contact lenses. The results of the visual functions tests indicated acceptable performance on all measures except fixation disparity. The high degree of variability found on this test suggested problems associated with the prescription lenses optical design, namely its high radius of curvature and its additional thickness. Field-of-view results indicated losses in visual field above those obtained with spectacle correction, but comparable to that found with the plano mask. Further development and testing are recommended.

**91-14. Test and evaluation report of the Physio Control Defibrillator/monitor model LIFEPAK™ 10.** March 1991. (ADA234593)

By Jeffrey D. Haun, Joseph R. Licina, Bill Olding, and Martin Quattlebaum.

The Physio Control Defibrillator/Monitor Model LIFEPAK™ 10 was tested for

electromagnetic interference/compatibility in the UH-60A helicopter under the U.S. Army Program for Testing and Evaluation of Equipment for Aeromedical Operations. The tests were conducted using current military and industrial standards and procedures for electromagnetic interference/compatibility and human factors. The LIFEPAK™ 10 passed the overall evaluation and is validated as compatible with U.S. Army aeromedical aircraft.

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